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Westmead

December 1876

Sent him The Parallel
Roads paper. - 25th

This bears upon the Report
of the Coal Commission
in which Pres. work
acted, & I was

Secretary. H. Campbell

ON THE
SECTION
OF

MESSRS. MEUX AND Co.'S ARTESIAN WELL

IN THE
TOTTENHAM-COURT ROAD,

WITH
NOTICES OF THE WELL AT CROSSNESS,
AND OF ANOTHER AT
SHOREHAM, KENT;

AND ON THE PROBABLE RANGE OF THE
LOWER GREENSAND AND PALÆOZOIC ROCKS UNDER LONDON.

BY
PROFESSOR J. PRESTWICH, M.A., F.R.S., F.G.S., ETC.

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1878.

On the SECTION of MESSRS. MEUX and Co.'s ARTESIAN WELL in the TOTTENHAM-COURT ROAD, with NOTICES of the WELL at CROSS-NESS, and of another at SHOREHAM, KENT; and on the probable RANGE of the LOWER GREENSAND and PALEOZOIC ROCKS under LONDON. By Professor J. PRESTWICH, M.A., F.R.S., F.G.S., &c.

IN 1851* I expressed an opinion that, as the Upper and Lower Greensands, with the intermediate Gault, cropped out from beneath the Chalk both on the north and south of London, the same strata, in all probability, passed beneath the chalk-basin without break, and that the *Lower Greensand* might be found available as an additional source of water supply to London. The boring made shortly afterwards at Kentish Town† by MM. Degousée and Laurent, of Paris, showed, on the contrary, that while the Upper Greensand and the Gault were prolonged as expected, the Lower Greensand was absent, and was replaced, at a depth of 1114 feet, by strata of *hard micaceous red and variegated fine-grained sandstones and clays*. These were traversed for a thickness of 188 feet, when the work was abandoned.

In the absence of fossils, and the confusion produced by the introduction from above of *débris* and extraneous fossils from the Gault and Upper Greensand, much uncertainty prevailed for a time with regard to the age of these sandstones, which were considered by some as modified forms of the Lower Greensand or the Wealden, and were referred by others to Permian or Triassic strata. From a subsequent examination of the *Old Red Sandstone* in the neighbourhood of Frome, I came to the conclusion that they belonged to strata of that age‡, as I found the Kentish-Town specimens agreed closely with the Mendip beds in lithological characters, whereas there was, on the whole, a want of agreement with the Permian or Triassic series. I was confirmed in this view after seeing the Red Sandstones and Marls, belonging to the Devonian series, which crop out from beneath the Coal-measures in the neighbourhood of Mons in Belgium.

Still, owing to the absence of fossils, an uncertainty existed on the subject, which has now been effectually removed by the recent boring at Messrs. Meux & Co.'s brewery. This well-known brewery is situated at the south end of the Tottenham Court Road, at its junction with Oxford Street. The original well was sunk many years ago, and carried into the Chalk to a depth of 365 feet. In

* See 'The Water-bearing Strata around London,' by the author. Van Voorst, 1851.

† Quart. Journ. Geol. Soc. vol. xii. p. 6, 1856.

‡ Report of Royal Coal Commission of 1869, vol. i. p. 161; Anniversary Address to the Geological Society for 1872, and Min. of Proc. Civil Engineers, vol. xxxvii. p. 14 (1874).

the hope of obtaining a better supply of water from the Lower Greensand, Messrs. Meux & Co. resolved to carry a boring down through the remainder of the Chalk and the Gault, in the hope of reaching the former formation.

The level of the surface at the brewery is 85 feet 7 inches above Ordnance datum, that of the Kentish-Town well being 186 feet 6 inches. A new bore-hole, of the large diameter of 13 inches, was commenced. At 840 feet the bore-hole was reduced to a diameter of 9 inches, and from 902 feet for the remainder of the depth to 7 inches. The clean, regular cores, often many feet in length, of the several formations passed through brought up by the diamond-boring process are very remarkable.

The Chalk was found to have a total thickness of $652\frac{1}{2}$ feet, while at Kentish Town it is 645 feet thick; the Upper Greensand 28 feet, and at Kentish Town $13\frac{3}{4}$ feet*; the Gault 160 feet, and at Kentish Town $130\frac{1}{2}$ feet. Here the similarity ends. At the base of the Gault, a seam from 3 to 4 feet thick of phosphatic nodules and quartzite pebbles was met with. Under this, the bore-hole entered a sandy calcareous stratum of a light ash-colour, which passed into a compact light-coloured or white limestone, and then into a rock having the appearance of an oolite, being composed of fine calcareous grit in a calcareous paste. Some portions of these strata were more sandy than others, and a small quantity of mica and a few grains of chlorite were occasionally to be detected. This rock was in the place of the *Lower Greensand*, but it bore no resemblance to our ordinary Lower Greensand. Fortunately, some of the beds contained plentiful casts and impressions of shells, which were recognized by Mr. Etheridge, of the Geological Survey, as Lower Greensand fossils. Possibly these beds may represent the middle division or the Ragstone.

The commoner forms were small species of *Cardium* and *Cerithium*, together with a *Trigonia* and an *Exogyra*, some corals and many Foraminifera; the only specific determinations, however, yet made are:—*Cardium Hillanum*, *Trigonia alæformis*, and *Trochocyathus Harveyanus*. These, however, with the general facies of the fossils, satisfied Mr. Etheridge that these beds are the representatives of the Lower Greensands of Kent.

The hopes that were hereupon raised, that, the Lower Greensand being reached, the ordinary loose sands which form so large a part of that formation in Kent and Buckinghamshire might be met with, and a supply of water obtained, were not, however, destined to be realized.

After passing through 64 feet of these calcareous strata, the lower portion of which became grey and argillaceous, the bore-hole suddenly entered, at a depth of 1064 feet, into mottled red, purple, and greenish shales, occasionally finely micaceous, in parts very calcareous,

* I have adopted Mr. Whitaker's reading (Mem. Geol. Survey, vol. iv. p. 498) for the thickness of this bed, in preference to the one originally given by myself: but still there is an uncertainty on this point.

and with a dip of 35° *. These, with lenticular seams or thin beds of hard grey and red sandstone or quartzite, and with beds of red marl, continued through a depth of 80 feet, when all doubt being removed as to the geological age of the strata, the work was stopped.

A good many fossils were met with from time to time in the shales, among which Mr. Etheridge recognized the following:—

Spirifer disjuncta.	Orthis.
Rhynchonella cuboides.	Chonetes.
Edmondia.	

The first two are Upper Devonian species, while the *Edmondia* is a characteristic Devonian genus†.

Further, in lithological characters, the rock-specimens obtained from this boring agree perfectly with those I had an opportunity of seeing, in company with Mr. Warrington Smyth and Dr. J. Evans, last year in the neighbourhood of Pernes, near Bethune, where the Upper Devonian strata crop out from beneath the Chalk, with a dip 28° S.W., and are in close relation with the adjacent Coal-measures at Marles and Auchy-au-Bois‡.

For particulars of the section, which I have given at the end of this paper (p. 912), I am indebted to Major Beaumont, the Managing Director of the Diamond-boring Company, and to Mr. Etheridge, aided by specimens in my own possession and in the Oxford University Museum, which has been liberally furnished with a very fine series of cores by Messrs. Meux & Co.

Thus the great problem of the existence of Palæozoic rocks at an accessible depth under London, and of the absence of the Jurassic series, as suggested upon sound theoretical grounds by Mr. Godwin-Austen, has been solved in the affirmative. This geologically important work further shows that while the range of the Lower Greensand is interrupted by the underground Palæozoic ridge, the limits of that interruption do not extend at this point south of a line passing through the centre of London.

The value of the *first* determination consists in the fact that in the range of the Carboniferous series through Belgium and the north of France they are everywhere accompanied, on the same strike, by Devonian strata, and the latter strata are constantly brought by great faults and flexures into juxtaposition with the Coal-measures.

* The cores gave so perfect a vertical section that the angle of the planes of bedding to a horizontal surface were clearly visible and easily measured. The direction of the strike was not, however, ascertained.

† Another specimen in my possession bears a close resemblance to *Rhynchonella boloniensis*, characteristic of the Upper Devonian of the north of France and Belgium.

‡ M. Breton's description of the Devonian strata met with in the boring given in fig. 2, p. 906, might pass for that of the Tottenham-Court-Road specimens. He says, "Ce sont d'abord des schistes rouges, puis des grès schisteux un peu micassés, bruns mélangés de vert, puis des marnes effervescentes vertes et rouges. . . . ensuite des schistes rouges, avec taches verdâtres, sableuses, fossilifères, contenant des plaquettes quartzites micassées très-dures," &c. ('Étude stratigraphique du Terrain houiller d'Auchy-au-Bois,' p. 39.)

This is especially the case on the south side of the great Coal-trough in the Liège, Mons, and Valenciennes Coal-fields. The Coal-measures are, all through these districts, greatly disturbed, thrown back on end, and not unfrequently reversed by the great disturbing axis of the Ardennes and Artois*.

A most remarkable instance of such a reversal has been recently brought to light in the Coal-works at Auchy-au-Bois near Lillers. As this is the most westerly point to which the Valenciennes coal-field has been traced under the Tertiary strata and the Chalk, and is the part of the basin nearest to England, I will briefly describe the circumstances of its discovery†.

Some years since the Coal-measures had been found to extend to near Bethune; but the many borings made further westward in the "Pas de Calais" were stopped either by the Mountain Limestone or by Devonian strata, so that further attempts were discouraged. In two borings at Auchy-au-Bois this was also the case; but the geological inferences from stratigraphical structure and organic remains were such as to lead the French geologists and M. Breton, the manager of the Company at that place, to believe that there was a reversal of the strata such as to render it possible that the younger strata might be found underlying the older.

Instead, therefore, of stopping the work on meeting with strata older than the coal, it was in this instance determined to continue. The result was as remarkable as it had previously been unexpected. In one boring (No. 15, fig. 2), the Devonian strata were reached at a depth of 131 metres, and at a depth of 168·30 metres the bore-hole passed, as was anticipated, into the *Carboniferous Limestone*. With the uncertainty, however, as to what might be the thickness of this formation, the bore-hole was not carried beyond a depth of 215·11 metres; but another bore-hole (No. 16, fig. 1) was commenced at a short distance to the north on the rise of the strata, and there, under the Cretaceous strata, at a depth of 148 metres, the *Carboniferous Limestone* was reached; at 170 metres the boring passed out of that formation into true *Coal-measures*, in which, at 185 metres, the bed of coal (o) was met with.

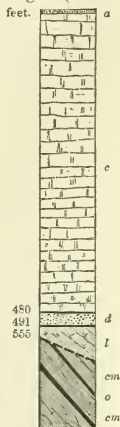
Another boring (No. 17, fig. 3) was then made further north, and there the Coal-measures were reached immediately beneath the "Tourtia," at a depth of 146 metres. A shaft was then sunk between the last two borings. As was expected, the *Carboniferous Limestone* was met with at a depth of 146·44 metres, which by its fossils (*Spirifer mosquensis*, *Athyris Roissyi*, *Rhynchonella pentatoma*, &c.) M. Breton identifies with the lower division of that formation—the "Calcaire de Tournay." These beds had a dip of 33° south, and extended to the depth of 155·40 metres, when a very acute fault was traversed and the Coal-measures reached—the latter consisting of

* See the sections given in my report "On the Probability of finding Coal in the South of England," &c., p. 161. Royal Commission on Coal Supply, 1869.

† This has been described by M. Breton in his "Étude sur le prolongement au sud de la zone houillère du Pas-de-Calais," *Annales de la Société Géologique du Nord*, tome iv. p. 138, 1876-77, and his 'Étude stratigraphique.'

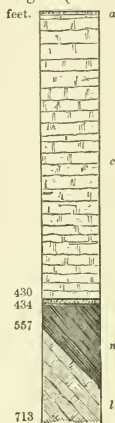
Figs. 1 and 2.—Sections of Borings at Auchy-au-Bois, near Lillers (Dépt. du Pas-de-Calais).

Fig. 1 (No. 16).



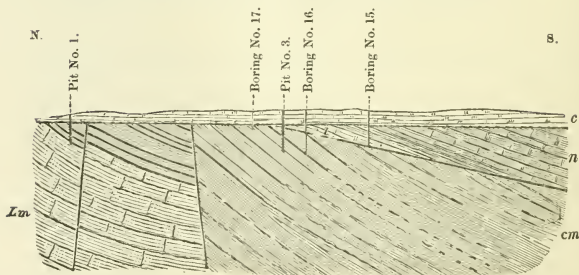
a. Gravel.
c. Chalk.
d. Tourtia.
n. Devonian strata.

Fig. 2 (No. 15).



l. Carboniferous strata.
cm. Coal-measures.
o. Coal-seam.

Fig. 3.—Section across the Auchy-au-Bois Coal-field.



c. Chalk.
n. Devonian.
l. Lower Carboniferous strata.

cm. Coal-measures.
Lm. Carboniferous Limestone.

shales and sandstones, with impressions and casts of the usual plants. At 167 metres a bed of coal, somewhat impure, but yielding large blocks, was come upon; its dip was 41° S.*

M. Breton explains these phenomena on the supposition that there is here a great fold of the Coal-measures enclosed between strata of Carboniferous Limestone, and that the Devonian strata pass over them by means of a reversal, accompanied by a fault and thrust, which has caused those beds to slide, as it were, over the Coal-measures at a very small angle. Fig. 3 is a generalized section of this singular Coal-field reduced from the sections and particulars (omitting some of the details) given in M. Breton's papers.

One great point of interest which the Auchy-au-Bois Coal-field presents is to be found in its relation to the probable extension of the Coal-measures under the same Cretaceous strata in England, and the light it throws upon the age of the Hardingham Coal-field.

Sir R. Murchison and Mr. Godwin-Austen considered this latter coal-field, which lies between Calais and Boulogne, to belong to a lower and more unproductive part of the Carboniferous series than the Belgian and Valenciennes field; and this view I adopted in my Report in 1869. From subsequent examination of that coal-field, I am now satisfied that the view taken by M. Gosselet† is the correct one, and in this my friend Mr. Godwin-Austen also now agrees.

According to M. Gosselet, the Hardingham Coal-field is a prolongation of that of Valenciennes. He proves it both by the lithological characters of the strata, by their organic remains, and by physical structure. Later observations at Auchy-au-Bois also show that the Coal-measures at Hardingham are exactly on the prolongation of the strike (about E. 30° S., and W. 30° N.) of the Auchy-au-Bois trough; though west of Auchy-au-Bois there is an apparent thinning out of the fold that leads to the supposition that the coal-strata are not continuous between the two places, but form separate basins.

The prolongation of the same strike and accompanying boundary faults across the Channel would place the southern boundary of any coal-field under the Tertiary and Cretaceous strata of South-east England on a line which would pass a little south of Maidstone, whence it would cross the Thames obliquely, and range a short distance north of London. It must be remembered, however, that although such strikes and such faults may maintain a certain mean average direction, they are liable to considerable deviations, so that any underground Coal-measures, if there, may be either somewhat to the north or to the south of this line; but it is nevertheless on or near this line that they should be first sought for. Their exact course can only be determined by experiment.

It is, in any case, of the highest interest to find that we have

* At the time we visited the pit the works had been carried deeper, and they were working a fine seam of coal, which in places was 4 metres thick.

† "Étude sur le Terrain Carbonifère du Boulonnais," *Mém. Soc. des Sc. Agr. &c. de Lille*, 3rd ser. vol. xi. 1873: see also M. Gosselet's various papers in the *Annales de la Soc. Géologique du Nord*.

under London a succession of strata of the same character as those met with in connexion with the Coal-measures of the north of France and Belgium; and we are confirmed in the hope I have before expressed that, to the north of the line just named, productive coal-basins of similar character may be met with underlying the Chalk and Tertiary strata of this country.

The attempt to determine the strike of Devonian strata at Messrs. Meux & Co.'s was not successful; but the general direction of the strata has been proved by the last deep boring at Crossness, near Blackwall, undertaken by the Metropolitan Board of Works. In this instance the Chalk and Gault were successfully traversed, when, in place of the Lower Greensand, mottled red, grey, and greenish hard sandstones and red, slightly calcareous, clays were met with; but, owing to the small size of the bore-hole, the specimens were so fragmentary and, as in the case at Kentish Town, so much mixed with débris and fossils from the Gault and Chalk, that their determination was for a time difficult. After, however, inspecting various specimens obtained in passing through the 60 feet of these strata, and eliminating all the sources of error, I have now no doubt of the identity of the beds with those at Kentish Town. This would indicate a strike somewhere between N.W. and S.E., or W.N.W. and E.S.E., corresponding with that of the Palæozoic rocks in the north of France. A section of Crossness well, for which I am indebted to the courtesy of the Board, is annexed (p. 913).

In considering this question, it must be borne in mind that whatever the relative position of the Devonian and Coal-strata may be, there is one circumstance relating to their occurrence in this part of England that is here likely practically to limit the winning of coal. If, as we believe, the Lower Greensand extends underground from its outcrop in Kent and Surrey as far as London, its presence in that area would present a most formidable barrier to the sinking of shafts to the Palæozoic strata, owing to the difficulty of passing through any great thickness of loose sands so highly charged with water and under such a pressure. To the north of London, where the Chalk and Gault rest directly on the Palæozoic rocks, this impediment does not exist; but how far the same order of superposition may be maintained can only be determined by trials in various places. The zone marked by the absence of the Lower Greensand cannot be many miles in width, as this formation reappears, although in less force than in Kent, from beneath the Gault in Buckinghamshire and Bedfordshire, 30 to 40 miles north of London, and may be prolonged under part of the Chalk hills of those counties and possibly of Hertfordshire.

This brings me to the *second* point of importance determined by Messrs. Meux & Co.'s well. Although the well at Kentish Town had unexpectedly disclosed the existence of Palæozoic strata directly under the Gault, I have always felt convinced that the Lower Greensand, so thick at Sevenoaks and Redhill, extended to or near to London, and that although the Tottenham-Court Road appeared to me too near Kentish Town for a successful trial, I considered

that water-bearing Greensand-beds might be found under Croydon or Sydenham, or possibly still nearer London* ; for with strata 400 to 500 feet thick at Redhill, indicating a deep-sea basin without any appearance of the proximity of land, it is evident that the shores of the old Lower Greensand sea were some distance off. There is there no evidence, as there is at Faringdon and in Cambridgeshire, of the proximity of a shore-line. The only question was how far north of Redhill and Reigate it might be.

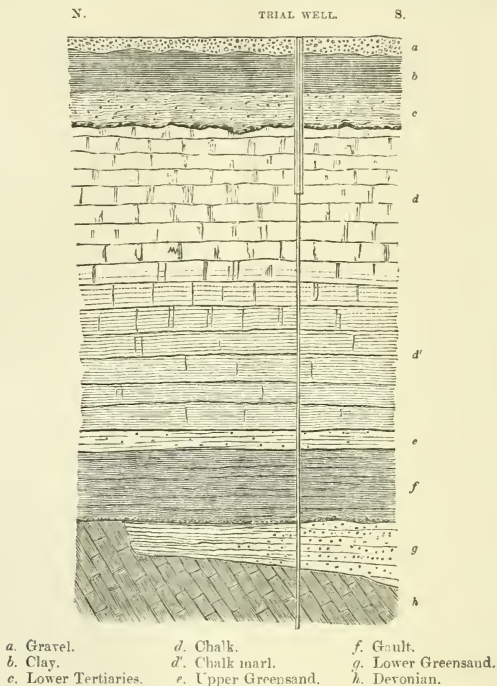
This has now been settled by the section of the Tottenham-Court-Road well. At Kentish Town there was no trace of any Lower-Greensand beds. At the Tottenham Court Road, on the contrary, they have not only set in, but have attained a thickness of 64 feet. The character of the few fossils indicates waters of small depth ; while the abnormal character of the strata is probably due to the existence of calcareous strata of Devonian (or Carboniferous ?) age in the adjacent cliffs or shore of the old Palæozoic land. It is to these that we must look for the origin of the calcareous matter which has replaced in greater part the loose quartzose and ferruginous sands of the Lower Greensand ; for on that old shore we might look for springs such as are now met with off many limestone coasts, where the shore-sands are converted into compact shelly limestones by the action of freshwater springs highly charged with carbonate of lime derived from the adjacent lands.

This old shore-line must lie somewhere between the south end of Tottenham Court Road and Kentish Town ; and the section between the two places may be represented by the following diagram, in which the Lower Greensand is assumed to end against an old underground cliff (fig. 4).

But whatever the origin and character of these Lower Greensand beds at this well, they must merge or pass into the great beds of quartzose sands, with their intercalated zone of Ragstone, which crop out from beneath the Gault at the foot of the North Downs ; and from the development which the formation has already attained in the short distance between Kentish Town and Oxford Street, it is probable that, with continued increasing dimensions, the sand-beds set in at no great distance to the south, and that therefore the *Lower Greensand* will be there found in the permeable condition necessary to store and transmit underground waters.

This surmise has been to a certain extent realized on the same line of country by the Artesian well recently sunk, at my suggestion, with much enterprise by my neighbour H. Bingham Mildmay, Esq., of Shoreham Place, near Sevenoaks, and which, so far as meeting with the Lower Greensand at about the estimated depth and obtaining a supply of water therefrom, proved successful. Mr. Mildmay's residence stands in the valley of the Darent, 12 ft. above the level of the stream, 5 miles north of Sevenoaks, and $2\frac{1}{2}$ miles distant in a straight line from the outcrop of the Lower Greensand. The level of the surface above the sea is 194 ft. and of the Greensand at its lowest point of outcrop about 225 ft. A shaft 25 ft. deep was first

* "Anniversary Address for 1872," Quart. Journ. Geol. Soc. vol. xxviii. p. lx.

Fig. 4.—*Probable Section between Kentish Town and Oxford Street.*Fig. 5.—*Diagram Section from the North Downs to London.*

N. S.

1 2 3 4 5 6 7 8 9 10

a b

1. Tertiary strata.	4. Lower Greensand.	8. Carboniferous strata.
2. Chalk.	5. Wealden.	9. Upper } Devonian strata.
3. Gault.	6. Jurassic strata.	10. Lower }
a. Kentish-Town Well.		b. Tottenham-Court-Road Well.

sunk, and then a bore-hole was carried down the rest of the way. The section obtained was as under* :—

	ft.
Soil and Chalk rubble.....	13
Chalk without flints (very hard)	112
Chalk marl (very argillaceous)	88
Upper Greensand	10
Gault.....	226
Lower Greensand (sand and sandstone)	26 +
	<hr/> 475

On reaching the Lower Greensand the water rose in a trial-pipe fixed into the bore-hole to a height of 12 ft. (or rather more) above the surface of the ground. But unfortunately, from the loose character of the beds and the small size of the bore-hole, it got largely filled with the sand, and the delivery of water has consequently always remained very slow and small. Added to this, the water is slightly ferruginous and, with the slow discharge, has shown but little improvement; still, after settlement, it is quite potable.

The experiment is nevertheless one of great interest, and the result would, there can be no doubt, have been far more successful could the tubes be properly cleared of sand. The thickness of the Gault is unusual.

Combining the several data now in our possession, the accompanying section (fig. 5) shows the probable position and range of the *Lower Greensand* and the position of the *Palæozoic rocks* under the London Basin.

In short, while there is every reason to hope that, on the south of London, we may yet find in the *Lower Greensand*, beneath the Tertiary strata and Chalk, a source of large and valuable water-supply for metropolitan purposes, there is strong reason to believe in the probability of the discovery to the north of London of *Carboniferous strata*, including possibly productive Coal-measures, under the same Cretaceous formations †. The position assigned to the latter in the diagram is merely hypothetical. Even if the beds at Kentish Town are lower in the series than those of Messrs. Meux & Co.'s boring, the Palæozoic strata are so disturbed and folded that neither the dip nor the relative position of the Devonian beds afford any certain guide to the position of the Carboniferous trough.

It is to be hoped that the accuracy of the geological hypothesis may ere long be tested by a series of carefully considered and systematic trial-borings in the neighbourhood of London, and the solution of these two important problems effected.

* The boring was made by Messrs. F. R. Baker and Sons, to whom and Mr. Mildmay I am indebted for these particulars.

† The westward prolongation of this underground belt of Palæozoic strata is not only indicated by the various pebbles of crystalline and metamorphic rocks met with in the Lower Greensand, and by the shore-conditions of this formation at Faringdon, but also by the apparent presence of the Trias under the Great Oolite at Oxford (as suggested by the author in a paper "On a Mineral Spring at Oxford," Proc. Ashmolean Soc. for 1876); while the existence of the Coal-measures themselves has recently been proved under the Jurassic series and the Trias near Burford, on the confines of Oxfordshire and Gloucestershire.

*Section of the Artesian Well at Messrs. Meux & Co.'s Brewery,
Tottenham Court Road, London.*

Depth.	Particulars of Well-section.	Thick-ness.	Geological Formation.	Thick-ness.
ft.	Flint Gravel	21 ft.	For details of these beds see Mr. Whitaker's "Geology of the London Basin," Mem. Geol. Surv. vol. iv. p. 525 ...)	156½ ft.
	London Clay	63½		
	Woolwich and Reading beds	51		
156½	Thanet Sands	21		
	White Chalk, with flints more or less plentiful; a few fine seams of grey clay in the lower part, and fossils often numerous, especially in the lines of bedding	447	MIDDLE CHALK	655½
603½	Compact light grey Chalk, with few fossils. <i>Inoceramus</i>	176½	LOWER CHALK	
	Grey Chalk-marl, with <i>Inoceramus Cuvieri</i> and <i>Ammonites varians</i> ...	32	CHALK MARL	
812	Micaceous light grey Sandstone, very slightly calcareous (firestone). <i>Ammonites splendens</i> ..	23	UPPER GREENSAND	23
840	Green and quartzose sand			
	Calcareous bluish-grey clay, with a few seams of calcareo-phosphatic nodules. <i>Ammonites splendens</i> , <i>A. lautus</i> , <i>Inoceramus concentricus</i> , <i>I. sulcatus</i> , <i>Dentalium medium</i> , <i>Belemnites ultimus</i> , and wood	157	GAULT	160
	Greensand and clay	2½		
	Seam of calcareo-phosphatic nodules and quartzite pebbles	½		
1000	Light-coloured limestone...	1		
	Seam of quartzite pebbles ..	½		
	Sandy limestone	3½		
	Light-coloured limestone; traces of fossils	29		
	Marly sand	1		
	Light greyish limestone, with angular grains of quartzose sand and a few specks of chlorite and mica. Numerous casts and impressions of shells:— <i>Cardium Hillanum</i> , <i>Trigonia alaeformis</i> , a small <i>Cerithium</i> , Corals, and Foraminifera	24	LOWER GREENSAND	64
	Light grey oolitic-looking rock	2		
1064	Rubby stone and clay.....	3		
	Mottled red, purple, and light green shales, very finely micaceous, and with well-preserved fossils in places; dips at an angle of 35°; a few thin seams of red and grey quartzite	80	UPPER DEVONIAN	80+
1144				

Section of second Well-boring at Crossness (on the south bank of the Thames below Blackwall), 1050 yards south of first boring.

	Particulars of Well-section.	Depth to top of each bed *.	Geological Formation.	Thick-ness.
1.	Soil.....	+ 3.60 ft.	ALLUVIAL BEDS ...	ft.
2.	Dark brown stiff clay ...	+ 2.60		21
3.	Blue silty clay	- 1.15		
4.	Peat	- 4.98		
5.	Blue silty sand	- 11.40	QUATERNARY	18
6.	River drift gravel.....	- 17.40		
7.	Very hard stiff blue clay	- 35.40		
8.	Stiff yellow clay and sand-layers	- 37.90		
9.	Hard grey sand, intersected with layers.....	- 39.40	WOOLWICH AND READING BEDS }	47
10.	Layers of tenacious clay of various hues and shells	- 47.85		
11.	Hard sand, with layers of clay	- 49.90		
12.	Stiff hard sandy clay ...	- 51.15		
13.	Very hard stiff sandy clay	- 54.90		
14.	Dark tenacious sandy clay	- 56.56		
15.	Very stiff hard clay	- 60.15		
16.	Dark green sand	- 62.15		
17.	Ditto and shells	- 63.65		
18.	Shell-bed	- 64.24		
19.	Dark green sand, with round pebbles of various sizes	- 66.15		
20.	Ditto, but no pebbles ...	- 69.90		
21.	Green clayey sand	- 70.40		
22.	Ditto and pebbles	- 72.40		
23.	Ditto and few pebbles...	- 73.40		
24.	Ditto	- 76.40		
25.	Greenish-grey sand and pebbles	- 77.40	THANET SANDS ...	50½
26.	Thanet sand	- 82.40		
27.	Layer of flints on top of chalk	- 132.90	MIDDLE and LOWER CHALK }	637½
28 }	Chalk and few layers of flint & rock Chalk-marl		
29 }			UPPER GREENSAND	65†
30.	Upper Greensand.....	- 764.40		
31.	Gault clay.....	- 829.40	GAULT	176
32.	Gault clay, full of stones, shells, pyrites		
33.	Top of Red Sandstone and bottom of Gault. Hard red rock-shale. Micaceous	- 1004.4	OLD RED SANDSTONE OF DEVONIAN	60
34.	Very hard grey rock. Micaceous	- 1012.4		
35.	Dark-red argillaceous shale rock	- 1016.4		
36.	Very hard quartzose red and grey rock	- 1023.4		
37.	Very hard quartzose greenish-grey rock ...	- 1030.9		
38.	Light-red shale.....	- 1038.4		
39.	Greenish-greyish shale ..	- 1040.4		
40.	Very sharp grey sand, with black grains	- 1044.4		
		- 1056.4		

* These depths have reference to Ordnance datum = 12.50 feet below T. H. W.

† This should probably be reduced, and the thickness of the Chalk increased.

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